

# The effect of combined transcranial pulsed current stimulation and transcutaneous electrical nerve stimulation on lower limb spasticity in children with spastic cerebral palsy classified on Gross Motor Function Classification System (GMFCS) levels III–V: a randomized and controlled clinical study

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## Research article

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# **Abstract**

## **Background**

In the current study, we applied a combination of non-invasive neuromodulation modalities concurrently with multiple stimulating electrodes. Specifically, we used transcranial pulsed current stimulation (tPCS) and transcutaneous electrical nerve stimulation (TENS) as a novel strategy for improving lower limb spasticity in children with spastic cerebral palsy (SCP) categorized on levels III–V of the Gross Motor Function Classification System (GMFCS) with minimal side effects.

## **Methods**

63 SCP children aged 2–12 years who were classified on levels III–V of the GMFCS were randomly assigned to one of two groups, resulting in 32 children in the experimental group and 31 children in the control group. The experimental group underwent a combination therapy of tPCS (400 Hz, 1 mA cerebello-cerebral stimulation) and TENS (400 Hz TENS, max 10 mA) for 30 min, followed by 30 min of physiotherapy daily for 12 weeks. The control group underwent physiotherapy only 30 mins per day for 12 weeks. In total, all groups underwent 60 treatment sessions. The primary outcome measures were the Modified Ashworth Scale (MAS) and Modified Tardieu Scale (MTS). Evaluations were performed three days before and after treatment.

## **Results**

We found a significant improvement in MAS and MTS scores of the lower limbs in the experimental group compared to the control group in the hip adductors (Left:  $p = 0.002$ ; Right:  $p = 0.002$ ), hamstrings (Left:  $p = 0.001$ ; Right:  $p < 0.001$ , and gastrocnemius (Left:  $p = 0.001$ ; Right:  $p = 0.000$ ). Moreover, MTS scores of R1, R2 and R2-R1 in left and right hip adduction, knee joint, and ankle joint all showed significant improvements ( $p \leq 0.05$ ). Analysis of MAS and MTS scores compared to baseline scores showed significant improvements in the experimental group but declines in the control group.

## **Conclusion**

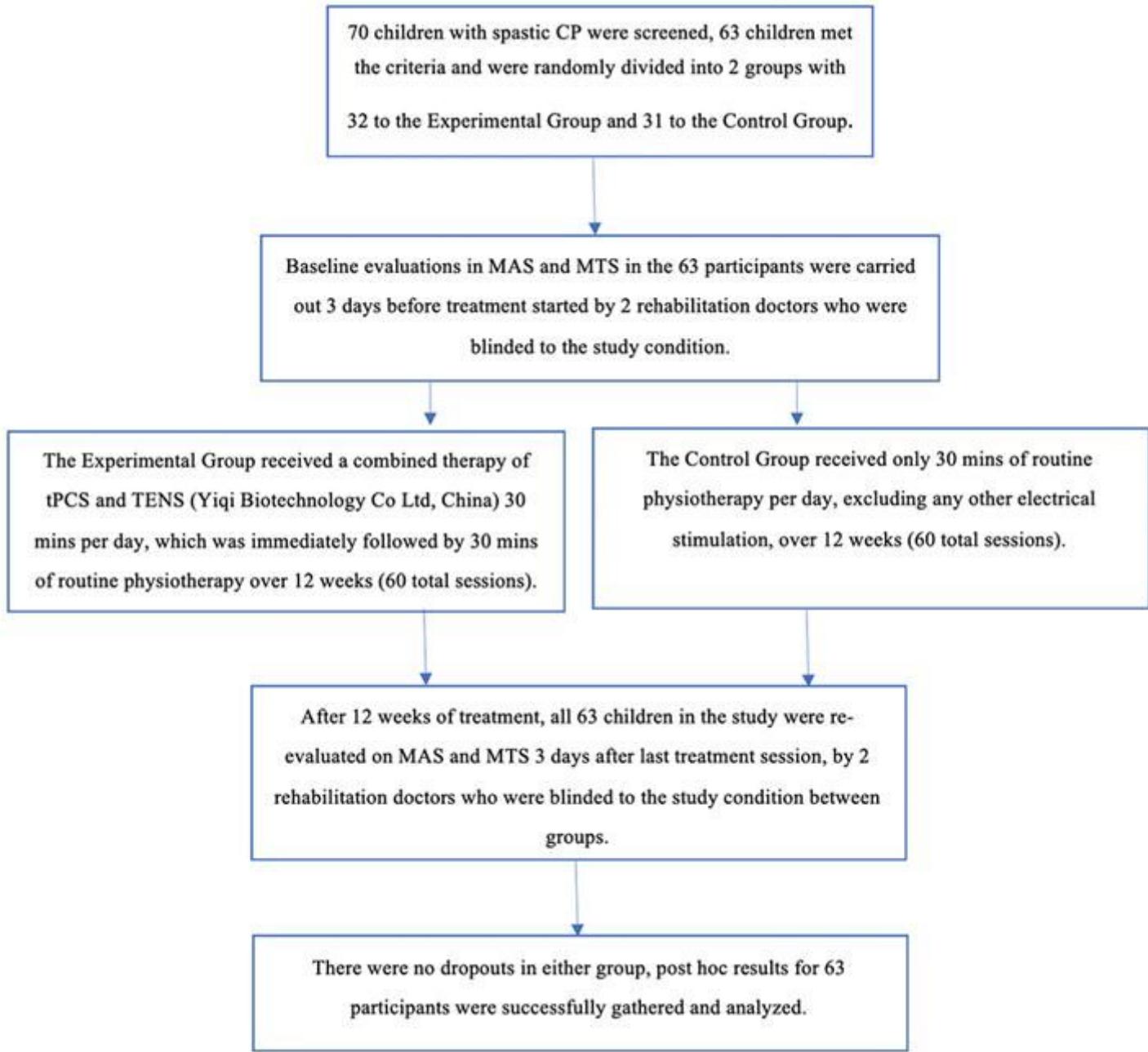
These results are among the first to demonstrate that a combination of tPCS and TENS can significantly improve lower limb spasticity in SCP children classified on GMFCS levels III–V with minimal side effects, presenting a novel strategy for addressing spasticity challenges in children with severe SCP. Trial registration: ChiCTR.org, ChiCTR1800020283,

## **Registration**

22 December 2018, (URL: <http://www.chictr.org.cn/edit.aspx?pid=33953&htm=4>).

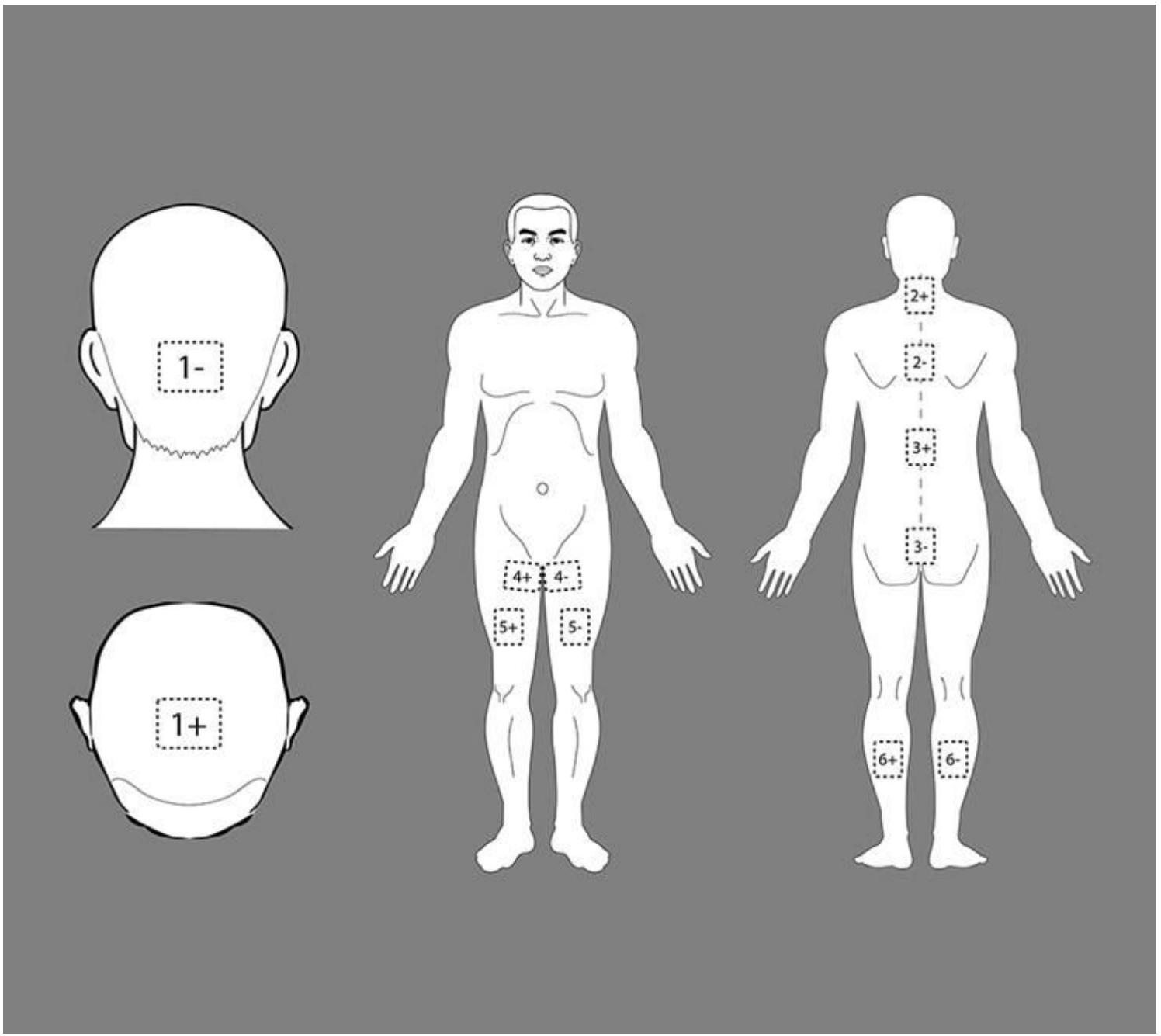
# **Full Text**

## Figures



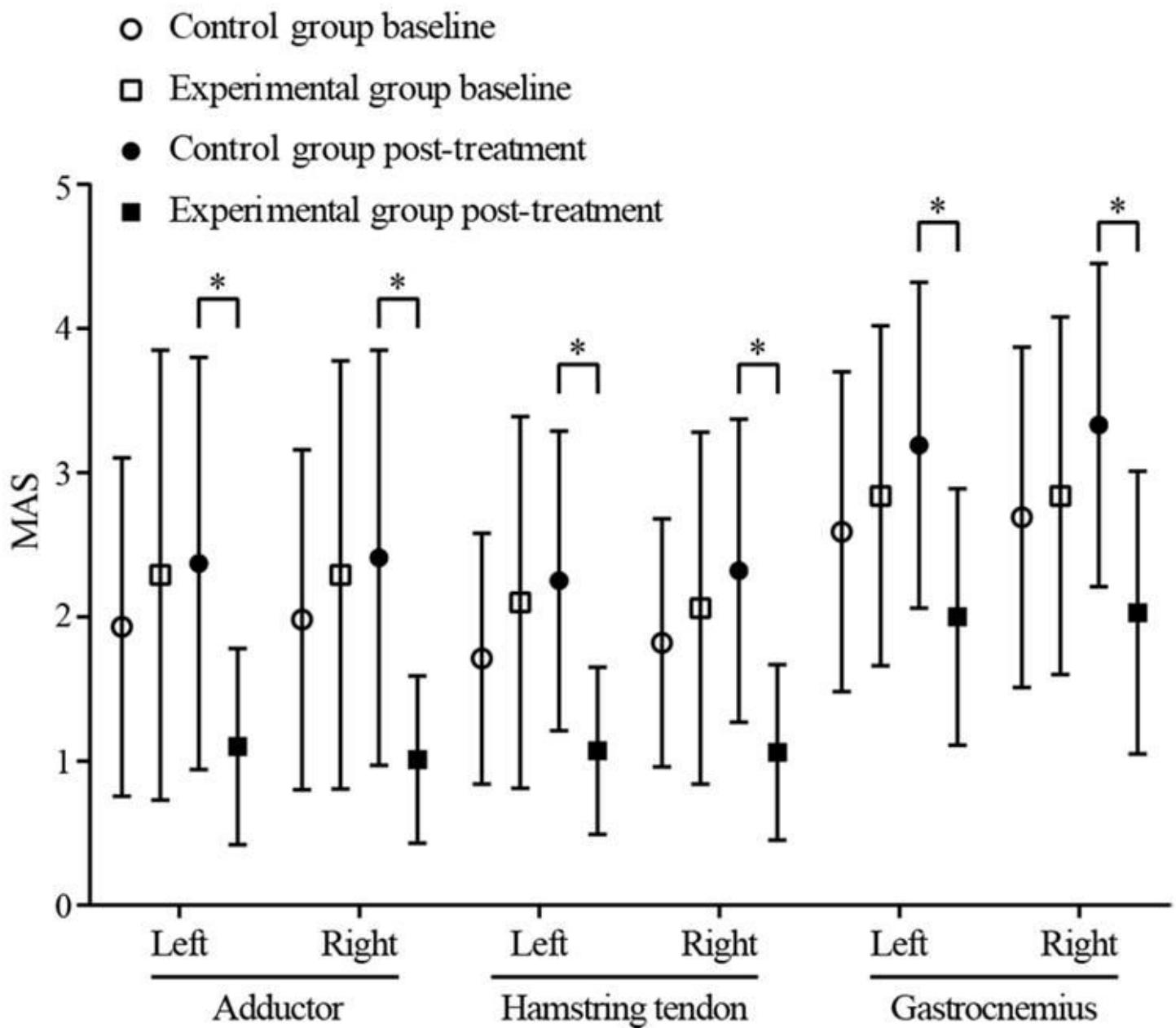
**Figure 1**

Flowchart of study based on Consolidated Standards of Reporting Trials



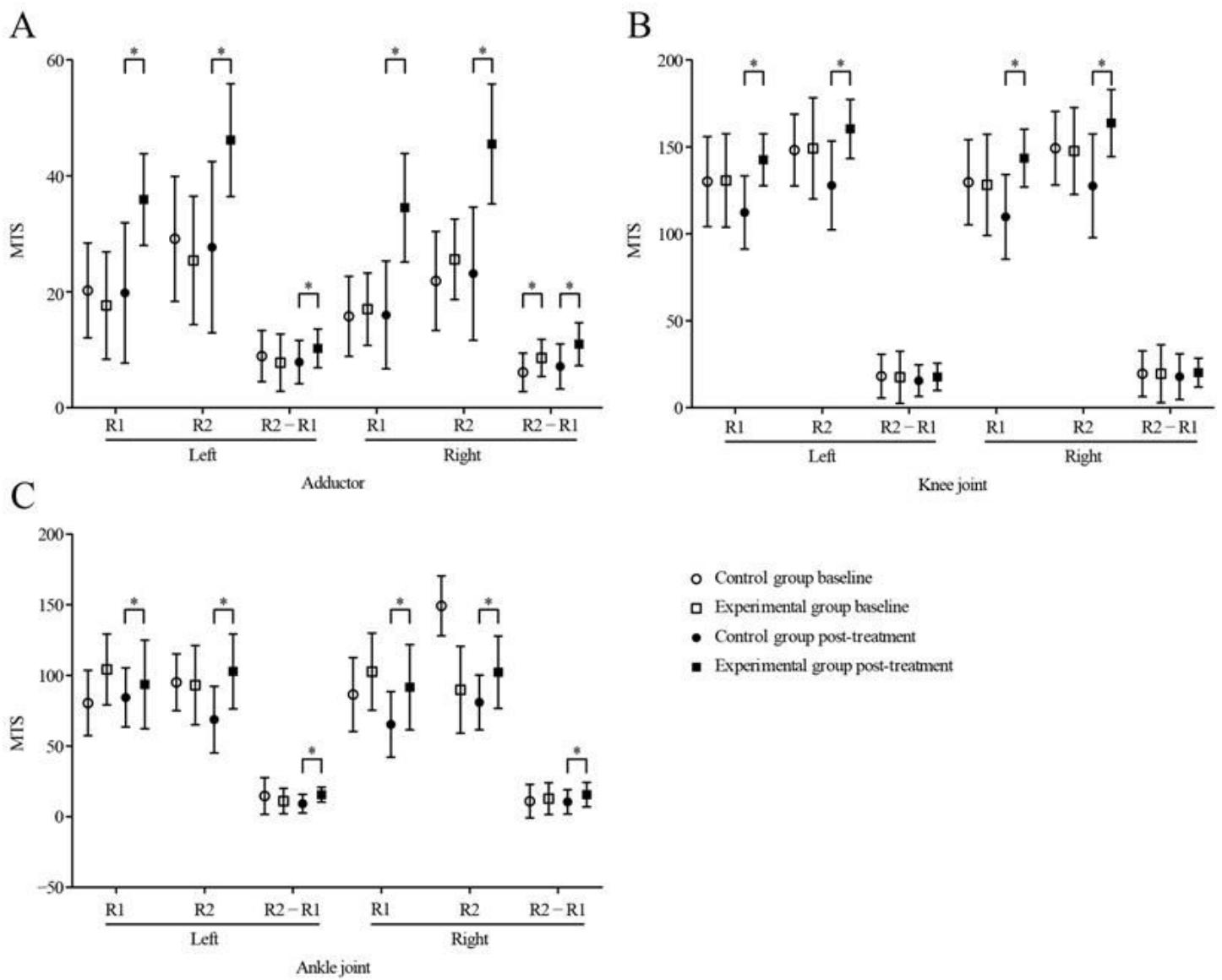
**Figure 2**

Position of surface gel electrodes during combined tPCS and TENS stimulation



**Figure 3**

Comparative analysis of Modified Ashworth Scale (MAS) in the two groups before and after treatment



**Figure 4**

Comparative analysis of Modified Tardieu Scale (MTS) scores in the two groups before and after treatment

## Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- Additionalfile2Trialprotocol.pdf
- Additionalfile1CONSORTChecklist.pdf